

**CLAIMS**

Thus, having described the systems and methods for confirming electrical connection defects, we claim the following:

1           1.       A method for confirming defects, comprising the following steps:  
 2           dividing the surface of a printed circuit board into a plurality of views;  
 3           associating an electrical connection with a corresponding view when a  
 4           characteristic associated with the connection in an observed image indicates that the  
 5           connection is defective;  
 6           analyzing the corresponding view to determine the slope of the surface of the  
 7           printed circuit board across the view;  
 8           adjusting the distance between the printed circuit board and a sensor in  
 9           response to the slope of the view; and  
 10          observing the characteristic associated with the connection in a subsequent  
 11          image.

1           2.       The method of claim 1, further comprising:  
 2           considering the connection acceptable when the characteristic observed in the  
 3           subsequent image is within a range of expected values.

1           3.       The method of claim 2, further comprising:  
 2           ignoring the acceptable determination from observation of a subsequent image  
 3           when the characteristic associated with the connection is indicative of a specific  
 4           defect.

1           4.       The method of claim 2, further comprising:  
 2           ignoring the acceptable determination from observation of a subsequent image  
 3           when the connection is associated with a specified device type.

1           5.       The method of claim 3, wherein the defect is a short circuit.

1           6.       The method of claim 4, wherein the specified device type is a ball-grid  
 2           array device.

1           7.       The method of claim 2, further comprising:  
2           ignoring the acceptable determination from observation of a subsequent image  
3           when the connection is associated with a plated through hole.

1           8.       The method of claim 1, wherein the step of observing comprises:  
2           deriving an adjustment range corresponding to the distance between the  
3           printed circuit board and a focal plane of a sensor;  
4           determining a number of adjustment steps contemplated to cover the  
5           adjustment range;  
6           repeating the adjusting and observing steps until the characteristic observed in  
7           the subsequent image is within a range of accepted values.

1           9.       The method of claim 8, further comprising:  
2           considering the connection acceptable when the characteristic observed in the  
3           subsequent image is within the range of accepted values.

1           10.      The method of claim 1, wherein the step of observing comprises:  
2           deriving an adjustment range for a focal plane of the sensor;  
3           determining a number of adjustment steps to cover the adjustment range;  
4           repeating the adjusting and observing steps until the number of adjustment  
5           steps has been exhausted and the characteristic observed in each of the subsequent  
6           images indicates that the connection is defective.

1           11.      The method of claim 10, further comprising:  
2           reporting that the connection is defective.

1           12.      The method of claim 11, wherein the step of reporting comprises  
2           storing an indicator that the connection failed a reexamination.

1           13.      The method of claim 1, wherein the step of analyzing the  
2           corresponding view comprises identifying a centroid of the view.

1           14.     The method of claim 13, further comprising:  
2           identifying the z-height of the centroid.

1           15.     The method of claim 14, wherein the z-height of the centroid is  
2     identified using a surface map of the printed circuit board.

1           16.     The method of claim 14, wherein the step of adjusting comprises  
2     assuming that the corresponding view is coplanar with a surface map plane that  
3     encompasses the centroid.

1           17.     The method of claim 14, wherein the step of adjusting comprises  
2     determining the maximum height deviation between each of the vertexes of the  
3     corresponding view and the centroid.

1           18.     An improved circuit board inspection system, comprising:  
2           means for segmenting a surface of a circuit board in response to an indication  
3     that an electrical connection on the circuit board is defective;  
4           means for associating the defective electrical connection with a corresponding  
5     segment; and  
6           means for observing a characteristic of each defective electrical connection  
7     that accounts for variation in height of the surface of the circuit board over the  
8     corresponding segment.

1           19.     The system of claim 18, wherein the means for segmenting divides the  
2     surface of the circuit board into a plurality of rectangular segments.

1           20.     The system of claim 19, wherein each of the plurality of rectangular  
2     segments encompasses an equivalent area of the surface.

1           21.     The system of claim 19, wherein the means for observing adjusts a  
2     focal plane of a sensor.

1           22.     The system of claim 21, wherein the focal plane of the sensor is  
2 adjusted in steps responsive to the maximum deviation in height across the segment.

1           23.     The system of claim 22, further comprising:  
2           means for reporting that an electrical connection is acceptable when the  
3 characteristic observed in a subsequent image is within an acceptable range.

1           24.     The system of claim 23, further comprising:  
2           means for filtering acceptable electrical connection determinations forwarded  
3 by the reporting means when the characteristic associated with the electrical  
4 connection is indicative of a specified defect condition.

1           25.     The system of claim 23, further comprising:  
2           means for filtering acceptable electrical connection determinations forwarded  
3 by the reporting means when the electrical connection is formed from a solder ball.

1           26.     The system of claim 23, further comprising:  
2           means for filtering acceptable electrical connection determinations forwarded  
3 by the reporting means when the electrical connection is associated with a plated-  
4 through hole.

1           27.     The system of claim 21, wherein the focal plane of the sensor is  
2 adjusted in steps over a sensor adjustment range.

1           28.     The system of claim 27, wherein the focal plane of the sensor is  
2 adjusted until the sensor reaches a limit of the sensor adjustment range.

1           29.     The system of claim 27, wherein the focal plane of the sensor is  
2 adjusted until the characteristic observed in each of the subsequent images indicates  
3 that the electrical connection is defective.

1           30.     The system of claim 29, further comprising:  
2           means for reporting that the electrical connection is defective.

1           31.     The method of claim 30, wherein the means for reporting comprises  
2     setting an indicator that the electrical connection has failed a reexamination.

1           32.     A defect confirmation program stored on a computer-readable medium,  
2     comprising:

3                 logic configured to segment a surface of a circuit board in response to an  
4     indication that at least one of a plurality of electrical connections is defective;

5                 logic configured to associate the at least one defective electrical connection  
6     with a corresponding segment;

7                 logic configured to adjust the focal plane of a sensor that accounts for variation  
8     in height of the surface of the circuit board across the corresponding segment;

9                 logic configured to record a characteristic of the at least one defective  
10    electrical connection;

11                logic configured to identify the electrical connection as acceptable in response  
12    to a condition where a measured characteristic value falls within a designated range;

13                logic configured to supersede a previous indication that the electrical  
14    connection is defective in response to the logic configured to identify.

1           33.     The program of claim 32, wherein the logic configured to segment  
2     divides the surface of the circuit board into a plurality of rectangular segments.

1           34.     The program of claim 33, wherein each of the plurality of rectangular  
2     segments encompasses an equivalent area.

1           35.     The program of claim 32, wherein the logic configured to adjust varies  
2     the focal plane of a sensor.

1           36.     The program of claim 35, wherein the focal plane of the sensor is  
2     varied in steps responsive to the slope of the segment.

1           37.     The program of claim 32, further comprising:  
2           logic configured to mark an electrical connection acceptable when a  
3     measurement of the characteristic observed in a subsequent image is within an  
4     accepted range of values.

1           38.     The program of claim 37, further comprising:  
2           logic configured to remove the mark when the characteristic associated with  
3     the electrical connection is indicative of a short circuit condition.

1           39.     The program of claim 37, further comprising:  
2           logic configured to remove the mark when the electrical connection is  
3     associated with a ball-grid array device.

1           40.     The program of claim 37, further comprising:  
2           logic configured to remove the mark when the electrical connection is  
3     associated with a plated-through hole.

1           41.     The program of claim 32, wherein the logic configured to adjust varies  
2     the distance between the focal plane of a sensor and the center of the corresponding  
3     segment in steps over a sensor adjustment range until the characteristic observed in an  
4     image is within an acceptable range.

1           42.     The program of claim 32, wherein the logic configured to adjust varies  
2     the distance between the focal plane of a sensor and the center of the corresponding  
3     segment in steps over a sensor adjustment range until the focal plane reaches a limit of  
4     the sensor adjustment range.